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cord, and paralyzers of the motor or efferent nerves.* For the explanation of these assertions, and for many other deeply interesting facts connected with this subject, the reader is referred to other sources.

On the Brain of Coryphodon.

By E. D. Cope.

(*Read before the American Philosophical Society, March* 16, 1877.)

The character of the brain in *Coryphodon* being an important desideratum, I endeavored to obtain a cast of the cranial cavity of a well preserved skull of a *C. elephantopus*, from the Wasatch beds of New Mexico. The hard sandstone matrix which filled it, was removed with some difficulty; the more as its surfaces were indurated by a cement containing much iron oxide. The osseous walls were found in a good state of preservation. It was ascertained that there is a considerable *foramen lacerum posterius*, but which is not nearly of such proportionate size as that in the genus *Tapirus*.

The form of the brain-cast thus obtained is very remarkable. Its distinguishing peculiarities are, (1) the small size of the cerebellum; (2) the large size of the region of the corpora quadrigemina; (3) the small size of the hemispheres; and (4) the enormous size of the olfactory lobes.

There is in the cast a strong constriction in front of the *medulla oblongata* on one side, which does not exist on the other side. It is uncertain which represents the true form, as regards the lateral portion, but that there was a step-like constriction across the base of the brain at this point, there is no doubt. The medulla is very stout and wider than the hemispheres; it is depressed, and a protuberance on the inferior part of each side has the appearance of the base of the eighth pair of nerves. The region of the cerebellum is depressed and does not present in the cast a distinct line of demarkation from the medulla. An indication of the vermis is seen in a low longitudinal median protuberance. In front of this a transverse shallow depression separates it from the middle brain.

The region of the *corpora quadrigemina* is the most bulky portion of the

coals had been placed. After sitting a few minutes he became completely paralyzed, and showed no signs of life, except a deep sigh every fifteen or twenty seconds. (*London Med. Gaz.*, Oct. 1846, quoted by Stillé, *Op. Cit.* p. 324.)

(5) Taylor states that in a case of suicide by nicotin, that the person "became insensible and powerless within a few seconds, and died in from three to five minutes; without convulsions."

A reference to the experiments related in the text, will show the entire similarity of the action of tobacco on man, to its action on the lower animals.

*H. C. Wood's Therapeutics, pp. 284, 340, 341.

brain. Superiorly it presents a large transverse tuberosity, with the lateral portions well defined, but not distinguished from the cast of the hemispheres on the median line. From its latero-superior prominences it extends downwards and forwards on each side, expanding laterally and narrowing as it approaches the inferior surface. Each lateral portion is separated from the hemisphere by a deep fissure, into which a prominent crest of the lateral cranial walls projects. This crest commences above, nearly at the plane of the superior wall, and curves downwards and forwards to below the middle of the cavity which contained the hemispheres. The inferior face of the middle region of the brain is bounded laterally by the projecting masses above described, posteriorly by the constriction in front of the medulla, and anteriorly by a slight contraction marking the boundary of the hemispheres. Its anterior lateral angles are continued into a fossa of the cranium, which I did not clear of the matrix, but which doubtless gives exit to the *foramina sphenoörbitale* and *rotundum.* The protuberance which occupies this fossa here, includes the base of the trigeminus nerve. A short distance posterior to this position on the inferior side of the lateral expansion of the middle brain, is the slight projection which covers the cavities of the *foramen ovale* and the *foramen lacerum posterius.* Between these on the middle line, is a pair of longitudinal elevations divided by a median longitudinal depression. Posteriorly they rise from the transverse constriction of the medulla; anteriorly they terminate rather abruptly, the one half at a point anterior to the other. This assymmetry is found in the osseous basis cranii, and is not due to accident. This median ridge is separated by a wide, shallow concavity from the lateral border on each side. A short distance anterior to the *foramen sphenoörbitale* is a small fossa which I have not explored, but which is the opening of the *foramen opticum.* They are of small size, indicating a corresponding character for the optic nerve.

The *cerebral hemispheres* are relatively and absolutely very small, their median long diameter being one-fifteenth the total length of the skull, or a little smaller than those of the *Uintatherium mirabile,* according to the figures and description of Marsh. They are together about as wide as deep posteriorly, but both diameters diminish rapidly forwards, the vertical the most rapidly. The profile slopes downwards and forwards to the base of the broad olfactory peduncles. There are no convolutions nor any decided indication of the Sylvian fissure,* but there are surface-casts of the small arteries that ramified in the dura mater. Owing to the prominence forwards of the inferior part of the middle brain, but a small part of the inferior surface of the hemisphere is visible. The olfactory lobes are the largest known among *Mammalia,* and greatly exceed those of *Uintatherium,* as described by Marsh, and even those of *Oxyæna.* Their peduncle is transversely oval in section, and is directed horizontally forwards for a distance about half as great as the length of the hemispheres without change of form. The mass then expands laterally and superiorly, rising upwards on each side of an osseous septum, which does not divide the olfactory lobes to the inferior face. They are thus deeply grooved above, and finally become furcate near to the extremity. Posterior to this point the inferior face rises, and the apices project laterally and forwards from the superior part of the lobe. The olfactory lobes consist, then, of a massive peduncle supporting a grooved subconical enlargement, which is bifurcate at the apex.*

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* Prof. Marsh (Amer. Journ. Sci. Arts, 1876, p. 166) states that both convolutions and a Sylvian fissure are present in *Uintatherium.* These assertions are not justified by his figures, nor by the probably similar brain of *Coryphodon.*

Since the internal walls of the skull show the foramina for the exits of the cranial nerves, we have a sufficient basis for the determination of the parts of the brain. In this attempt we are met by the difficulties which are inherent in the use of a cast to represent a brain. Although the *foramina sphenoörbitale* and *rotundum* can be readily fixed, their position is such as to give the point of exit of the nervus trigeminus an unusually inferior position. This appears to be the case to a still greater extent in the *Uintatherium,*† where the lateral descending masses are at the same time not nearly so largely developed as in *Coryphodon.* The large inferior area enclosed between these boundaries is then homologous with the *pons varolii* or that part of the encephalon which is covered by it. Its appearance in *Uintatherium* supports this identification, but its proportions and anterior position in *Coryphodon* depart more widely from the usual form. The two anterior submedian ridges of its surface, faintly indicated in *Uintatherium,* may be the homologues of the pronounced median ribs in *Coryphodon* which resemble a continuation of the anterior pyramids of the medulla oblongata. As they are not very distinctly marked in the medulla of *Coryphodon,* their identification may be uncertain, but they look like that portion of the anterior pyramids which is continuous with the crura cerebri, and which are concealed in *Mammalia* by the pons varolii. Their prominence in *Coryphodon* indicates that the pons is wanting in this genus as in the *Reptilia.* A shallow concavity of the sphenoid bone between the origins of the trigemini indicates the position of a pituitary body or hypophysis.

In profile the brain closely resembles in form that of a lizard, *e. g.,* an *Amiva,* excepting that in the latter the cerebellum is more elevated. The extension downwards and forwards of the middle brain with its projection below the hemispheres is common to both, but the inferior portions at least, do not appear to be homologous in the two. In the *Coryphodon,* the lateral projections correspond with the exits of the trigeminus from the skull; in the *Amiva* this part terminates in the optic tracts. The superior portions of the middle brain correspond in appearance and relative size with that of the *Amiva,* but a clear difficulty in identifying them in the two types, is derived from the difference in their inferior connections. One result of the examination is assured, viz.: that this region is no part of the cerebral hemispheres, and that it is entirely uncovered by them. As it is not the cerebellum, it stands in the position of the corpora quadrigemina, or perhaps the posterior pair more especially. As the homologies of this region in the vertebrate brain are not yet determined, further attempts to identify this part of it in the *Amblypoda* must be postponed for the present. The structure is in any event entirely different from that seen in any recent *Mammalia,* or in any Mammal of a period more modern than the Eocene period, and one that not only entitles these animals to a position in a peculiar order, but also in a special division of the class, even more distinct than those based by Prof. Owen on the modifications of the structure of the brain. The homologies of the olfactory lobes are simple, but their extent and form resembles nothing known among mammals, even far exceeding in size those of *Uintatherium.* On the other hand, they resemble those of reptiles, especially of the lizards, but are less deeply bifurcate anteriorly than in them. In the *Coryphodon elephantopus* they equal in length the middle brain and hemispheres together, and their bulb equals the hemispheres in transverse and vertical diameter.

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* Measurements of this brain are given in the article on *Coryphodon elephantopus,* in my forthcoming report on the vertebrate Paleontology of New Mexico, Vol. IV, of the report of Lieut. G. M. Wheeler.

† See Amer. Journ. Sci. Arts, 1876, pl. iv, p. 165.

The nearest approach to the form of the brain in the *Amblypoda,* is seen in that of the *Arctocyon primævus,* a Creodont which represented the *Carnivora* in the same lower Eocene fauna, and was actually associated with *Coryphodon* in France. This brain is described and figured by Prof. Gervais, Nouv. Archives du Muséum, vi., 1870, p. 150, Pl. 6 f. 4, who notices the remerkable exposure of the middle brain or corpora quadrigemina. Among *Mammalia* of later ages some of the extinct South American *Edentata,* present the greatest resemblances, although slight ones. Among these may be noticed the small and transverse cerebellum, and especially the lateral expansion of the region anterior to it. To what portion of the brain this expansion belongs, is not known, but it is not unlike the lateral mass in *Coryphodon,* as, *e. g.*, in the *Eutatus seguini,** Gervais. There is, however, nothing exposed on the superior surface in the Edentata which appears to be the middle brain ; hence the difference from the brain of the *Amblypoda* is very considerable.

In reviewing the evidence brought together up to the present time, the writer is of the opinion that the type of brain shown to exist in the *Amblypoda,* and *Creodonta,* is as distinct from those characterizing the primary divisions of the *Mammalia,* as they are from each other; and that it necessitates the establishment of a special sub-class for their reception of at least equal rank with the groups *Gyrencephala, Lissencephala* and *Lyencephala.* This may be called *Protencephala,* with the following definition: Cerebral hemispheres smooth, small, leaving not only the cerebellum but the middle brain exposed behind, and contracting into the

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*Figured in the important Memoir of Gervais, already quoted, Nouv. Arch. Mus., 1869, v., p. 42.

very large olfactory lobes in front. Cerebellum very small and flat; middle brain large. This character is sustained by that of the ankle joint, which, existing in two such distinct divisions as the *Amblypoda* and *Creodonta*, may be found to characterize the entire sub-class, but this is not yet certain; it is as follows: Tibio-astragalar articulation flat, and without groove or segment of pulley.

This sub-class stands below the *Lyencephala* in its position, approximating the reptiles in the points above mentioned, more nearly than the latter do. It includes two orders, one ungulate, the *Amblypoda*, the other unguiculate, the *Bunotheria*.* To the former belong the sub-orders *Pantodonta* and *Dinocerata;* to the latter the *Creodonta* and probably the *Tillodonta* and *Tæniodonta.* Whether the *Mesodonta* belong to it is not certainly ascertained, while the *Insectivora* do not belong to it, as they are rightly placed in the sub-class *Lissencephala.*

Lartet first pointed out the fact of the successive increase in the size of the brain of the *Mammalia* with the advance of Geologic time; and Marsh has stated that this increase is to be observed principally in the relative size of the cerebral hemispheres. I would correct the latter statement so far as to add, that the increase of size is to be seen in the cerebellum as much as in the hemisphere. It is also evident that the relative decrease is in the middle-brain and olfactory lobes.

Explanation of Plates.

Pl. I. Cast of brain cavity of *Coryphodon elephantopus*, two-thirds the natural size. The right bulbus of the olfactory lobe is probably too large above, owing to the want of preservation of the superior wall of the cavity.

Fig. 1. Superior view; fig. 2, the left side; t. base of the trigeminus nerve.

Pl. II. The same. Fig. 1, from below; fig. 2, posterior; fig. 3, anterior views. t. base of the trigeminus nerve; md. base of the mandibular branch of the trigeminus; p, ribs continuous with anterior pyramids.

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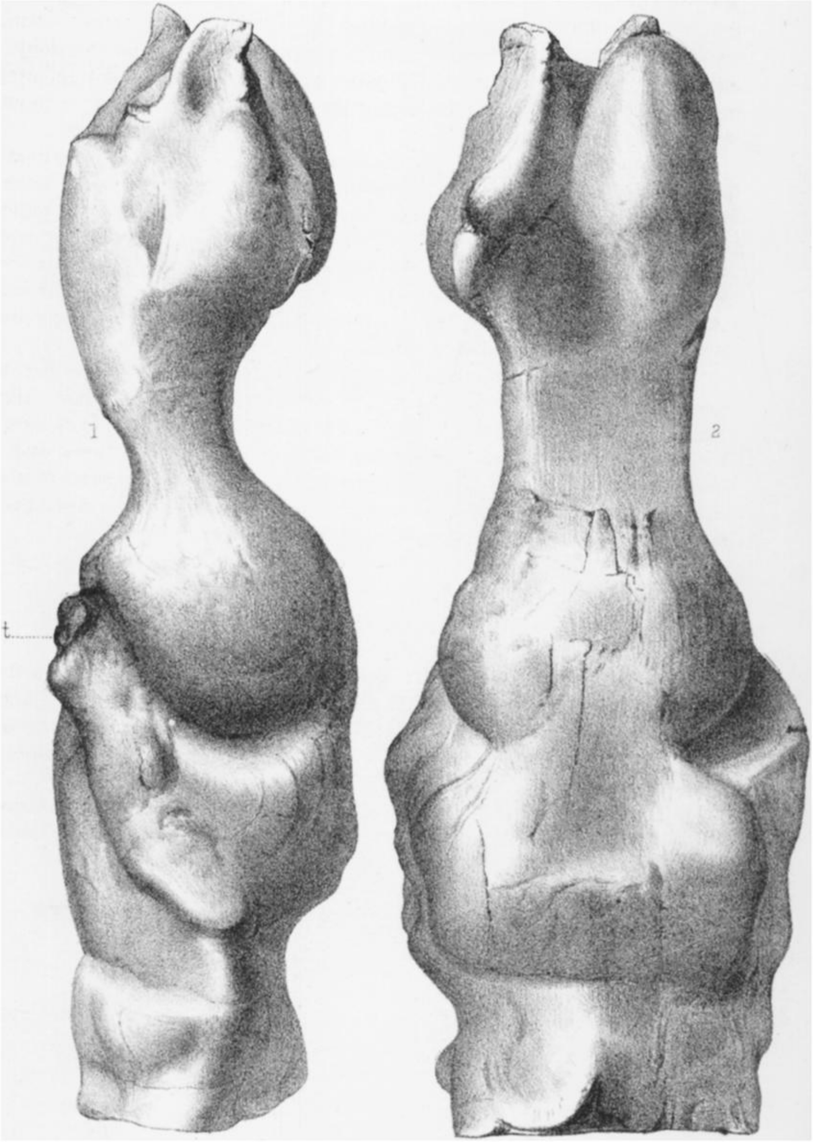
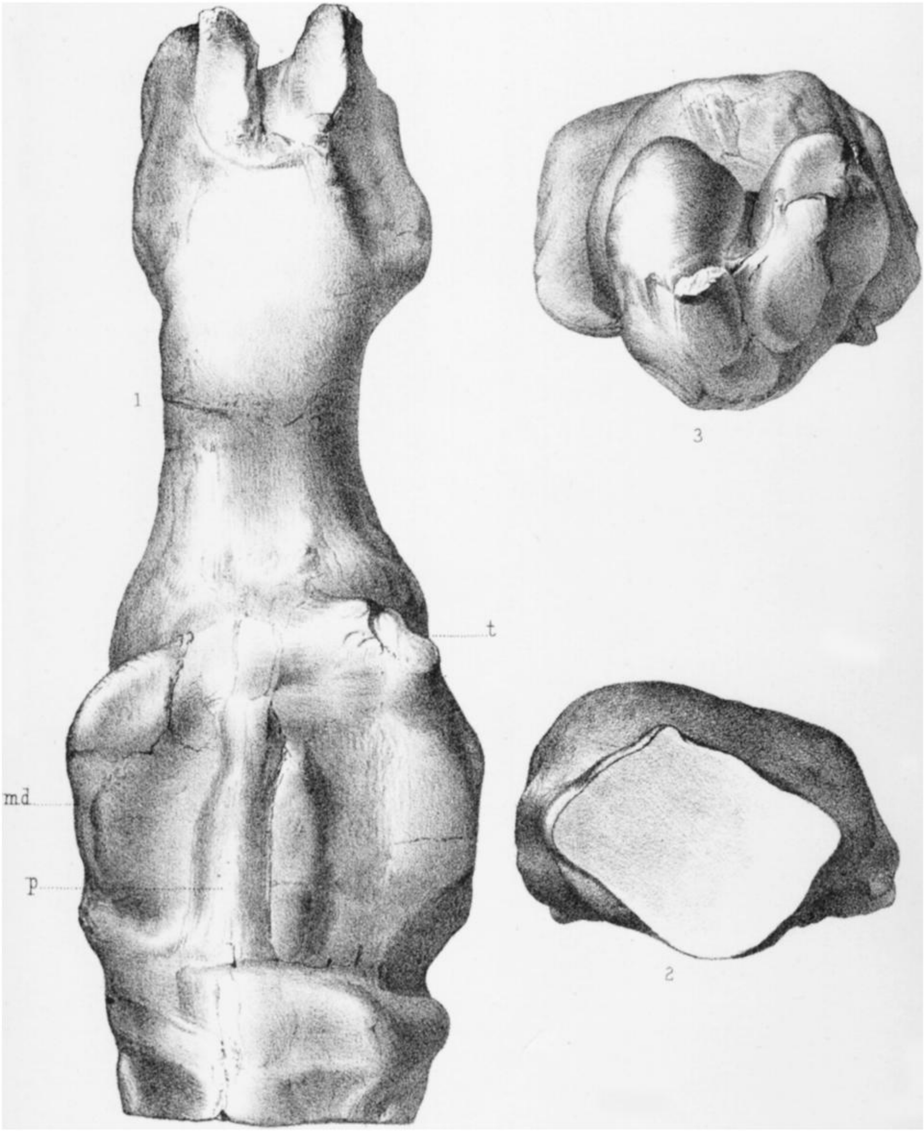
* See Proceedings Academy Natural Sciences of Philadelphia, 1876, p. 88.



Coryphodon elephantopus $\frac{2}{3}$.



Coryphodon elephantopus $\frac{2}{3}$.